

Auditory Brainstem Response

using SmartEP

What is ABR?

Auditory Brainstem Responses are potential differences generated when a person's ear is stimulated with any kind of sound. The potential difference originates in the VIII cranial nerve and the auditory brainstem system. These potential differences can be evoked using controlled stimulation, allowing acquisition of these differences by averaging the acquired signal over a specified period of time. The ABR response is commonly found between one and fifteen milliseconds from the time of stimulation.

The recordings acquired will contain certain peaks and valleys. A standard ABR recording will contain seven peaks, some more identifiable than others, peak five being the most prominent. The amplitudes, latencies and relationship of those peaks and valleys can be used to diagnose certain pathological conditions. ABR responses are most commonly acquired using surface electrodes.

Why acquire ABRs?

Auditory brainstem responses may be used to diagnose certain auditory conditions. This type of testing can provide the physician with very useful information about hearing loss in a patient. This technique is especially helpful to test infants and newborns that cannot yet respond to behavioral testing (many states now require hearing screening of newborns). It may also be helpful to test adult patients with a certain degree of mental impairment, such as the autistic and developmentally delayed.

ABR testing can help determine the amount and type of hearing loss at specific frequencies, (i.e. hearing threshold), depending on the cause of hearing impairment. ABR testing can also provide information about existing acoustic neuromas that may be causing a degree of hearing loss and the presence of nervous system abnormalities, particularly referring to the VIII nerve and auditory brainstem.

Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient lies down on a comfortable bed. The patient must be instructed to relax during testing. It is recommended that the patient avoid stimulants, such as caffeine, before testing.

Electrode Placement

Electrodes may be connected using the following configuration:

- **Right Inverting (-):** right ear mastoid or ear lobe.
- **Left Inverting (-):** left ear mastoid or ear lobe.
- **Non-Inverting (+):** high forehead, use a Y-adapter to join channels.
- **Ground:** low forehead.

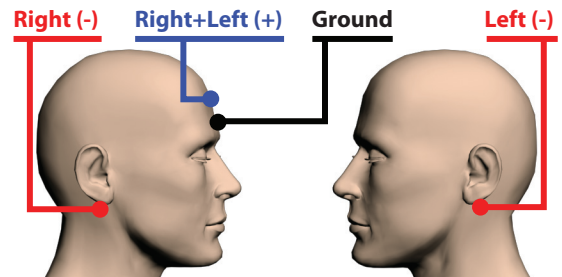


Fig.1 - Electrode positions.

When testing using a single channel amplifier, connect the **RED** electrode socket to the Right mastoid, the **BLUE** electrode socket to the Left mastoid, and the **Black** electrode socket to the high forehead. Remember to flip the amplifier switch to the correct position before starting acquisition. When using the USBLite hardware platform, make sure to choose the "Right-Left" designation option in the EEG and Amplifier window if using this setup.

Keep in mind that using different electrode locations will yield recordings with slightly different wave morphology. Consult the SmartEP manual for additional electrode placement details.

Electrode Usage

Surface electrodes are sufficient for acquiring ABR recordings. Clean and prepare electrode sites in order to reduce the impedance and acquire a clearer recording.

Setting up SmartEP

Acquiring ABRs is SmartEP's main function. The system may be setup with a few clicks of the mouse. Complete the following steps in the order outlined, use the test settings that best fit your requirements or use the recommended settings shown on the next section:

1. Under **[STIMULUS > MODALITY]** in the main menu, make sure **[AUDITORY > ABR]** is selected.
2. Set the stimulus, click on the **[STIM]** button from the control panel and set the stimulus type, duration, frequency, window, masking and transducer, as necessary.
3. Click on the **[EEG AND AMPLIFIER]** button on the control panel and set the filters, notch filter, artifact rejection ratio and region and desired amplification for each channel.
4. On the control panel, set rate, polarity, intensity and the number of sweeps.
5. Press the **[ACQUIRE]** button to start. Repeat acquisition 2 to 4 times.

SmartEP allows automation of the acquisition process; consult your user's manual to learn how to create your own automated testing protocol or how to save settings files for future use.

Make sure to carefully select your filter settings in the EEG and Amplifier window. Note that an unfiltered recording can always be filtered digitally to obtain a smoother waveform; however, hardware filtering cannot be undone.

Recommended Test Settings

This list shows the recommended settings for ABR acquisition:

- **Stimulus:** click.
- **Duration:** 0.1 milliseconds.
- **Masking:** optional.
- **Rate:** 27.7 per second; slower rates can be used to enhance wave I.
- **Polarity:** rarefaction; use alternating if there is stimulus artifact.
- **Transducers:** insert earphones.
- **Intensity:** 70 dB HL to start, then up or down

in 10 dB steps for threshold search; 80 to 95 dB HL for neurodiagnosis.

- **Filters:** 100 - 3000 Hz for adults; 100 - 1500 Hz for smoother recordings; 30 - 1500 Hz for infants.
- **Notch Filter:** OFF; turn ON only when power line noise is present.
- **Amplification (gain):** 100K
- **Analysis Time window:** 0 - 12 milliseconds
- **Sweeps:** 1024.
- **Electrode Placement:** ipsilateral or contralateral array.

Marking Peaks

To accurately diagnose a condition, you may need to obtain latencies and amplitudes by marking peaks. Peaks I to VII may be marked, when recognizable, by following these steps for each of the peak markers to be placed:

1. Click on the peak label you wish to mark (I-VII) from the tool bar, it will turn red when chosen.
2. Click the location on the waveform where the label should be placed.
3. Once placed, drag the top marker of the labels to the top of the peak, if needed.
4. To obtain waveform amplitudes, drag the bottom marker to the valley following the peak.

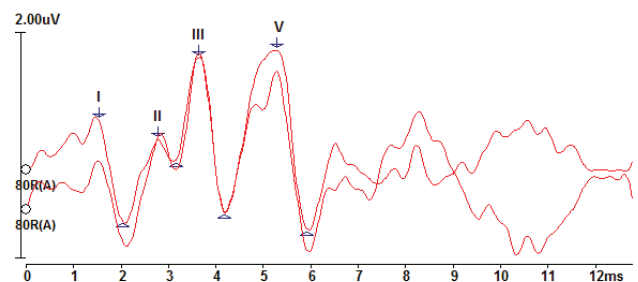


Fig.2 - Sample click ABR recording.

The graph shows suggested label placement for an acquired waveform. Since label placement is subjective, all results must be evaluated by an audiologist or medical professional trained in ABR techniques.

Printing

Select Print Report or Print Page from the SmartEP main menu to print a report of the currently displayed waveforms. You may also save page or report to PDF for an electronic version. See the SmartEP manual for other report generation options.